



Snowy Plover Monitoring in the Golden Gate National Recreation Area

Summary Report 2015–2019

Natural Resource Report NPS/SFAN/NRR—2023/2606



ON THE COVER

A western snowy plover (*Charadrius alexandrinus nivosus*) on the beach at the Crissy Field Wildlife Protection Area, San Francisco, California. The U.S. Coast Guard Wharf is immediately in the background, with the Golden Gate Bridge and Marin Headlands in the distance.

Photo credit: R. Townsend (NPS).

Snowy Plover Monitoring in the Golden Gate National Recreation Area

Summary Report 2015–2019

Natural Resource Report NPS/SFAN/NRR—2023/2606

Rachel K. Townsend and William W. Merkle

National Park Service
Fort Cronkhite, Bldg. 1062
Sausalito, CA 94965

December 2023

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible and technically accurate.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the [San Francisco Bay Area Network Inventory and Monitoring website](#) and the [Natural Resource Publications Management website](#). If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Please cite this publication as:

Townsend, R. K., and W. W. Merkle. 2023. Snowy plover monitoring in the Golden Gate National Recreation Area: Summary report 2015–2019. Natural Resource Report NPS/SFAN/NRR—2023/2606. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2301403>

Contents

	Page
Figures.....	iv
Tables.....	v
Abstract.....	vi
Acknowledgments.....	vi
Introduction.....	1
Monitoring Objectives	4
Methods.....	5
Study Area.....	5
Monitoring History and Study Design	5
Field Methods.....	7
Statistical Methods	8
Results: Ocean Beach	10
Overwintering Population Parameters.....	10
Temporal and Spatial Distribution	11
People and Dogs.....	13
Results: Crissy Field	16
Overwintering Population Size.....	16
Temporal and Spatial Distribution	16
People and Dogs.....	18
Discussion	20
Literature Cited	22

Figures

	Page
Figure 1. Ocean Beach and Crissy Field wintering areas for snowy plovers at Golden Gate National Recreation Area, San Francisco, California.	1
Figure 2. Snowy plover census area at Ocean Beach, San Francisco	6
Figure 3. Snowy plover census area at Crissy Field, San Francisco.....	7
Figure 4. Winter season averages ($\pm$ SE) and survey-year maxima for snowy plovers on Ocean Beach from 1994 to 2019	10
Figure 5. Monthly average ($\pm$ SE) number of snowy plovers observed per survey at Ocean Beach for survey years 1994 through 2014 compared to the same for survey years 2015 through 2019.	11
Figure 6. Percentage of snowy plover observations from 1994 through 2014 and from 2015 through 2019 by sector on Ocean Beach	13
Figure 7. The annual median number of people per hour in the Snowy Plover Protection Area at Ocean Beach (Sectors 4–12) from survey year 1994 to 2019.....	14
Figure 8. Median number of dogs per hour and percentage of dogs unleashed at the Ocean Beach Snowy Plover Protection Area, from survey year 1994 to 2019, including changing leash regulations.	15
Figure 9. Winter season averages ($\pm$ SE) and survey-year maxima for snowy plovers on Crissy Field from 2006 to 2019	16
Figure 10. Monthly average ($\pm$ SE) number of snowy plovers observed per survey at Crissy Field for survey years 2006 through 2014 compared to the same for survey years 2015 through 2019.	17
Figure 11. The annual median number of people per hour in the Crissy Field Wildlife Protection Area, from survey year 2006 to 2019.....	18
Figure 12. Median number of dogs per hour at the Crissy Field Wildlife Protection Area (WPA), from 2006 through 2019	19

Tables

	Page
Table 1. First and last dates snowy plovers were observed at Ocean Beach and snowy plover counts observed on those dates for survey years 1994 through 2019.....	11
Table 2. First and last dates snowy plovers were observed at Crissy Field and snowy plover counts observed on those dates for survey years 2006 through 2019.....	17

Abstract

This report summarizes results from five seasons, 2015–2019, of Golden Gate National Recreation Area’s western snowy plover (*Charadrius nivosus nivosus*) monitoring program. The goals of our monitoring program are to estimate trends in the overwintering snowy plover population size and distribution, as well as to track potential disturbance threats to snowy plovers. We surveyed Ocean Beach and Crissy Field for snowy plovers twice a week every other week, from 01-July 2015 to 13-May 2020. During each of the five years, we observed snowy plover counts that were higher than long-term average counts calculated from 1994 to 2019 on Ocean Beach, with a record maximum count of 106 plovers in 2015. We also observed higher-than-average numbers of snowy plovers on Crissy Field, ranging from a maximum count of six in 2017 to a record maximum count of 12 in 2019. Additional field seasons and analyses are necessary to determine population trends for these two beaches.

Following recent use patterns at Ocean Beach, snowy plovers were primarily observed in the wider area of beach between Lawton and Lincoln streets. At Crissy Field, snowy plovers were only found in the Wildlife Protection Area to the east of the US Coast Guard pier. Leash non-compliance rates at Ocean Beach remain high, approaching 80% of dogs observed unleashed in the Snowy Plover Protection Area. In contrast, many fewer dogs—mostly on leash—were observed in the Wildlife Protection Area at Crissy Field, where the area is smaller and where National Park Service (NPS) staff installed protective fencing, entrance gates, and signage in 2010. Dog owners were often observed approaching Crissy Field’s fenced Wildlife Protection Area but turning back at the fence without entering. Continued low levels of compliance with leash regulations at Ocean Beach indicate a need to enhance outreach and enforcement actions related to off-leash dog walking.

Acknowledgments

The initial western snowy plover monitoring program at Golden Gate National Recreation Area (GOGA) was developed by Lynne Stenzel and Gary Page of Point Blue Conservation Science, and Daphne Hatch of GOGA. Monitoring was initiated in 1994, and through the persistence of GOGA staff, continues today. The authors thank the numerous interns and volunteers that have contributed thousands of hours assisting with the snowy plover monitoring program at GOGA. The National Park Service’s San Francisco Bay Area Network Inventory and Monitoring Program provided support for updating our snowy plover monitoring protocol, published in 2014. Last, but not least, thank you to Lizzy Edson who provided support for data management and reporting.

Introduction

Western snowy plovers (*Charadrius nivosus nivosus*) regularly occur in overwintering flocks at Ocean Beach and smaller flocks at Crissy Field in the Golden Gate National Recreation Area (GOGA), a unit of the National Park Service (Figure 1). We refer to “overwintering” as the period the birds spend on the beaches between nesting seasons, spanning from late summer through spring. Snowy plovers were undoubtedly much more common in San Francisco before urban conversion of the vast dune complex that used to cover much of the area. Recently, snowy plovers observed on Ocean Beach and Crissy Field represented about 2% of the snowy plovers recorded in the United States Fish and Wildlife Service (USFWS) winter season counts conducted annually along the U.S. Pacific coast (USFWS 2019). The western snowy plover is found along the Pacific coast from Washington to Baja California. The populations of snowy plovers that nest adjacent to tidal waters along the Pacific coast of North America (within 50 miles) from southern Washington to Baja California were listed as threatened under the Endangered Species Act by the USFWS in March 1993 (USFWS 2007). The populations of snowy plovers that nest in interior California have been classified by the State of California as a species of special concern but have no federal designation (Shuford et al. 2008). In winter, both the federally threatened Pacific coast population and the non-federally listed interior nesting snowy plover population can be found along the Pacific coast from southern Washington to Baja California (Page et al. 1986, 1995).



Figure 1. Ocean Beach and Crissy Field wintering areas for snowy plovers at Golden Gate National Recreation Area, San Francisco, California.

Snowy plover populations have declined over the last century (USFWS 2007), as well as significant declines in breeding and wintering populations along the California coast from the late 1970s to 2000 (Page and Stenzel 1981, USFWS 2007). The reasons for decline and degree of threats vary by geographic area; however, the USFWS identified the primary threat as habitat destruction and degradation (USFWS 2007). Habitat degradation is primarily caused by urban development, introduced beachgrass, expanding predator populations, and human disturbance.

Among the factors contributing to population declines of snowy plovers are heavy human use of beaches in or near urban areas and associated disturbance to roosting plovers by people and dogs (Burger 1986, Klein 1993, USFWS 1993, Page et al. 1995, Lafferty et al. 2006). When shorebirds are disturbed, they must spend more energy on vigilance and avoidance behaviors at the cost of opportunities for foraging and resting (Burger 1986, Hatch 1996). High visitation by people and dogs, particularly off-leash dogs, has been noted as a major source of disturbance to snowy plovers on Ocean Beach and Crissy Field (Hatch 1996, NPS 2006a, Zlatunich 2007).

Regulations related to dog walking on GOGA beaches have changed frequently over the past few decades, making it difficult to gain compliance with the current, seasonal regulations requiring pets to be on leash. For a complete summary of dog-walking regulations at GOGA see the Final Dog Management Plan / Environmental Impact Statement (NPS 2016). The 1979 GOGA Pet Policy informally identified several areas of the park as suitable for off-leash use by dogs under voice control, including Ocean Beach and Crissy Field. Under direction of a USFWS Biological Opinion for a sand movement project, the park started enforcing a dog on leash restriction to benefit snowy plovers during the 1996 season. Crissy Field, including the beach, was restored in 1999. Part of the beach at Crissy Field and nearshore waters were designated a Wildlife Protection Area (WPA) that restricted dog use. Snowy plovers regularly started using the Crissy Field WPA beach for overwintering in 2004. In December 2004, leash restrictions at Ocean Beach and Crissy Field WPA were removed as part of a court ruling (U.S. District Court of Northern California 2005). In November of 2006, seasonal leash requirements were reinstated, and in September 2008, a final rule was issued by the NPS, which requires dogs to be on-leash in the Snowy Plover Protection Area at Ocean Beach and the Wildlife Protection Area of Crissy Field, except for the period from May 15 to July 1, when dogs can be off-leash in those areas (36 CFR 7.97).

Loss of habitat is also a factor contributing to the population decline of plovers (USFWS 2007). In particular, coastal erosion and the spread of European beach grass (*Ammophila arenaria*), which was introduced in an attempt to stabilize dunes, adversely impacts the snowy plover population at Ocean Beach (Stenzel et al. 1995, USFWS 2007). Sea-level rise and increased storm surge associated with climate change also threaten snowy plover habitat at both Ocean Beach and Crissy Field (Heberger et al. 2011). There is ongoing sand management and beach nourishment outside the plover area at Ocean Beach that will continue periodically as needed through beach monitoring. Beach and dune habitat at Crissy Field were restored in 1999, with snowy plovers starting to use this area in 2005. The Crissy Field WPA beach quickly accreted sand after its restoration, making a wider, sandy beach that may have served to attract snowy plovers (Brindock and Colwell 2011). Currently, this beach is

no longer accreting sand, and if the beach begins eroding, it may become less attractive to snowy plovers over time.

Monitoring Objectives

The specific monitoring objectives for the GOGA snowy plover monitoring program (Merkle et al. 2014) are to:

1. Determine trends in snowy plover winter season average population size at Ocean Beach and Crissy Field.
2. Determine trends in the spatial distribution of snowy plovers during the winter season at Ocean Beach and Crissy Field.

In addition to monitoring long-term population and distribution changes, GOGA also collects data to inform management decisions, under the following objectives:

1. Determine the phenology of snowy plover arrival and departure dates from Ocean Beach and Crissy Field.
2. Monitor number and distribution of people and dogs at Ocean Beach and Crissy Field.
3. Monitor compliance rates for seasonal restrictions requiring pets to be on-leash in the Snowy Plover Protection Area (SPPA) and Wildlife Protection Area (WPA) from July 1 through May 15.
4. Monitor the rates of dogs chasing snowy plovers or other shorebirds at Ocean Beach and Crissy Field.

In addition to meeting specific objectives, regular monitoring also allows for consistent observation of wildlife and interactions with recreational activities, as well as providing opportunities for public outreach related to protecting snowy plovers.

Methods

Study Area

Ocean Beach in San Francisco is the longest stretch of dune-backed beach between Point Reyes and Half Moon Bay on the outer California coast (Figure 1), providing important habitat for migratory and non-breeding shorebirds (Stenzel et al. 1995). From 1997 to 1999, approximately 100 acres of Crissy Field (Figure 1) were restored by enhancing and protecting coastal dunes, removing rubble from the beach, and constructing a 20-acre tidal marsh (Jones and Stokes Associates, Inc. 1996). A portion of the beach in the Crissy Field area was designated as a WPA, largely to benefit shorebirds and other birds using the nearshore waters of the San Francisco Bay. The beach at the Crissy Field WPA provides important habitat along the highly modified San Francisco Bay shoreline. The GOGA snowy plover populations are accessible to a large urban population of people, providing viewing, education, outreach, and opportunities for engagement in stewardship. There are no recent or historical nesting records for snowy plovers on GOGA beaches, although they breed on nearby beaches within about 25 miles to the north at Point Reyes National Seashore, as well as south of GOGA, on salt ponds at Don Edwards San Francisco Bay National Wildlife Refuge.

Monitoring History and Study Design

From 1979 to 1985, NPS and partners surveyed Ocean Beach irregularly for snowy plovers. During this time only a handful of plovers were observed, with annual maximum plover counts ranging from four to 16 (Page et al. 1986). From 1988 to 1994, Point Reyes Bird Observatory (PRBO, now known as Point Blue Conservation Science) volunteers conducted snowy plover counts on Ocean Beach from Lincoln Street to Noriega or Sloat Boulevard as part of coordinated efforts to count plovers along the California coast (Hatch 1996).

GOGA implemented a snowy plover monitoring program in December 1994 using a monitoring protocol developed by PRBO and NPS (Stenzel et al. 1995). Surveyors continued monitoring snowy plovers on Ocean Beach largely using the methods from this protocol through the present. We divided Ocean Beach into roughly equal sized sectors for monitoring based upon roads and associated sand-ladder access and other permanent features (Figure 2). In addition, based upon a study of disturbance at Ocean Beach, dogs were observed chasing snowy plovers and disturbing plovers or chasing other shorebirds during 111 surveys totaling approximately 40 hours of direct plover observation from 1994 to 1996 (Hatch 1996). People, aircraft, bulldozers, bicycles, and kite flying also disturbed plovers. However, observers noted that snowy plovers were more likely to fly when disturbed by dogs as compared to disturbances by people, where the plovers tended to walk or run away (Hatch 1996). This observation is consistent with findings at other beaches (Lafferty et al. 2006).



Figure 2. Snowy plover census area at Ocean Beach, San Francisco. The Snowy Plover Protection Area extends from Stairwell 21 in the north to Sloat Blvd. in the south (Sectors 4 through 12).

Snowy plovers first regularly started using Crissy Field in 2005, and we added formal monitoring based on the Ocean Beach protocol in 2006. That same year, the San Francisco Bay Area Network Inventory and Monitoring Program of the NPS (Adams et al. 2006) identified western snowy plovers as a Vital Sign for long-term monitoring (Figure 3). Therefore, we put the protocol through a rigorous development and peer-review process. We updated and formalized all elements of the GOGA snowy plover monitoring program including monitoring objectives, field methods, data management and verification, data analysis and reporting, and field-staff training, culminating in the publication of the snowy plover monitoring protocol for Golden Gate National Recreation Area (Merkle et al. 2014). Since that time, we have documented a small population of 1–9 overwintering plovers in this area. During that period, nearly all plover observations occurred in Sector 2 (Figure 3)

of the Crissy Field monitoring area with a handful of observations in Sector 1 (Townsend and Merkle 2020).

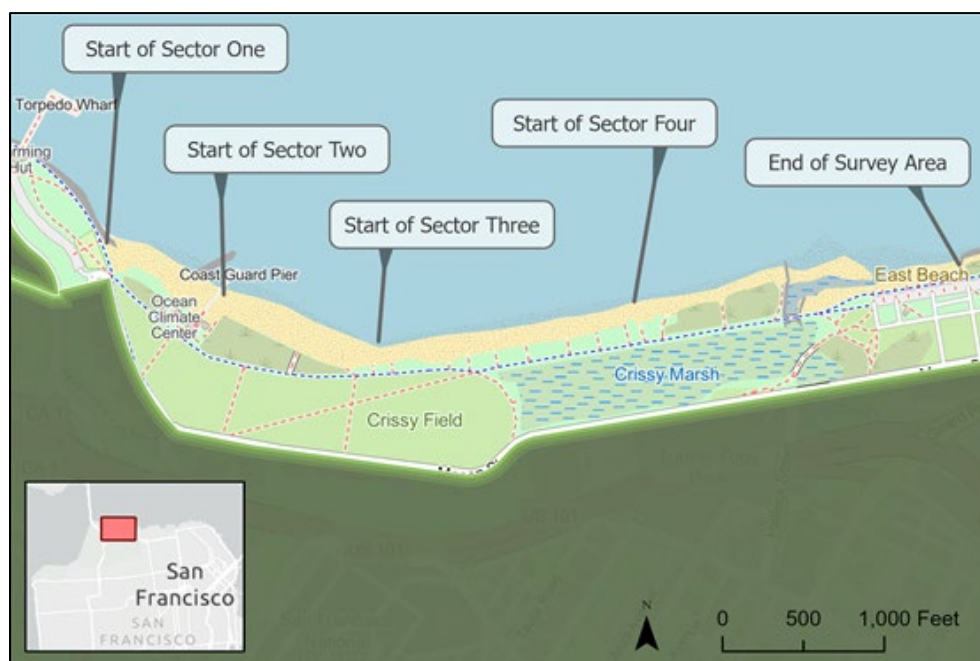


Figure 3. Snowy plover census area at Crissy Field, San Francisco.

Field Methods

All snowy plover surveys followed the guidance of our peer-reviewed monitoring protocol (Merkle et al. 2014). To capture the full range of recreational use, we split the surveys evenly between weekday mornings and weekend afternoons. On weekday morning surveys, we typically observed fewer people and dogs. In contrast, weekend afternoon surveys had the potential for high numbers of people and dogs on the beaches, as well as the possibility of observing more disturbances to snowy plovers. However, recreational use of the beaches was often influenced by weather, with high numbers of people visiting the beaches on warm, sunny days, regardless of whether it was a weekend.

Snowy plovers regularly occur at Ocean Beach and Crissy Field during their non-breeding season, from July through mid-April or May (Page et al. 1986, NPS 2006a). We started field surveys for snowy plovers during the first week of July, before snowy plovers were likely to be present and continued through the end of the non-breeding season, which was typically early May. Staff surveyed until plovers were not observed in two consecutive surveys in different bi-weekly survey windows (e.g., no plovers observed on a Saturday survey and no plovers observed 1.5 weeks later during the Wednesday survey).

Observers walked the entire beach project area, which is an efficient way of counting all plovers on the beach. By dividing the beach into sectors, we tracked the snowy plover distribution, as well as human and dog occurrence on different areas of each beach. We calculated encounter rates for people

and dogs by recording observer time spent in each sector. Observers also recorded other potential threats and disturbance to snowy plovers by sector. Surveyors recorded the start and end times for each sector's survey. Observations were made by slowly walking along the beach, stopping every 50 to 150 m and scanning about 100 to 200 m ahead while searching for snowy plovers. If multiple surveyors were present, each one was responsible for one portion of the data and data sheets. For example, one data sheet tracked the number of snowy plovers encountered, the time and sector they were encountered in, whether they were foraging, as well as the beach elevation zone and substrate where they were located. Surveyors noted observations of banded snowy plovers, including the unique color-band combination when they could be discerned. A separate data sheet tracked counts of potential disturbances, including the number of people, dogs (noting numbers on-leash, off-leash within 10 feet of their owner, roaming, or chasing shorebirds or plovers), equestrians, vehicles, predators, aircraft, kite flying, and other potential sources of disturbance. A third data sheet tracked counts of other shorebird species encountered. We entered the data in a Microsoft Access database specifically designed for this project. All data management and analysis followed procedures from the Merkle et al. (2014) monitoring protocol. All data were error checked and accepted prior to analysis for this report.

Statistical Methods

We defined a complete survey as completely searching all sectors of a given beach on a single day. We included only complete surveys in the following data analysis.

We defined a survey year as starting on the day of the first survey, typically in July, and running until the last survey day which typically occurred in April or May of the following year. For example, the 2019 survey year began in July 2019 and ended in May 2020.

We defined a snowy plover count as the sum of all sector plover counts recorded on a given beach within a single day. The maximum count for a beach equated to the highest snowy plover count observed during a single day over the entire survey year at that beach and occurred when plovers were migrating (i.e., outside the period we defined as the winter season).

We defined the winter season as the months of November through February, when snowy plover numbers on GOGA beaches were typically relatively stable. We calculated the winter season average as the mean of the snowy plover counts from surveys conducted from November through February each survey year. We calculated the standard error (SE) of the mean to estimate the deviation of our sample mean from the true population mean. For comparison, we also calculated long-term averages using winter season count data for the entire reporting period, 1994 through 2019 for Ocean Beach, and 2006 through 2019 for Crissy Field.

We calculated the monthly average count and associated SE of all snowy plover counts recorded during a given month during a particular survey year or series of years.

We calculated the percentage of snowy plovers per sector as the sum of counts of snowy plovers observed in a particular sector divided by the sum of all survey counts for a given beach in a survey year or series of years.

We evaluated number of disturbances per hour only for the SPPA (Sectors 4 to 12 at Ocean Beach) and the WPA (Sectors 1 and 2 at Crissy Field). Because we spent variable amounts of time per sector, we first recorded the amount of time spent surveying each sector (sector time) during a given survey day. We then calculated the total survey time for that survey day by summing all the sector times for a given protected area. We determined encounter rates for number of people (or dogs) observed per hour by dividing the number of people (or dogs) observed in a protected area by the sum of sector times for that area. The median number of people (or dogs) per hour per survey year was the middle value from a ranked list of these values for an odd number of samples. For an even number of samples, we took the average of the ranked values number $n/2$ and $(n/2)+1$, where n equals the number of surveys in a survey year.

The park enacted a leash regulation for the SPPA that was in force from 01-July through 15-May each survey year. As an indication of visitor non-compliance with the leash regulation during those dates, we calculated the percentage of unleashed dogs in the SPPA by dividing the total number of unleashed dogs (i.e., the sum of dogs categorized as either off-leash, roaming, chasing shorebirds, or chasing snowy plovers) by the total number of dogs observed within Sectors 4 through 12 in a survey. We then grouped those non-compliance values by survey year to determine the median percentage of unleashed dogs per survey year.

To explore potential population trends, we performed linear regressions on winter season averages and survey-year maxima from 1994 to 2019 for Ocean Beach and from 2006 to 2019 for Chrissy Field using the `lm` function in R with 95% confidence intervals (R Core Team 2022).

Results: Ocean Beach

Overwintering Population Parameters

From 1-July 2015 to 13-May 2020, the survey team conducted approximately 30 to 35 surveys per survey year on Ocean Beach. The average snowy plover count for survey years 2015–2019 was higher than that for 1994–2014 (44.5 and 26.8, respectively), with the average count for each year in 2015–2019 also exceeding the 1994–2014 average. Moreover, the average snowy plover maxima for survey years 2015–2019 was higher than that for 1994–2014 (82.6 and 43.1, respectively) and ranged from a low of 60 plovers in 2017 to a record high of 106 plovers in 2015 (Figure 4). From 1994 to 2019, snowy plover winter season averages increased slightly ($r^2 = 0.14$, $p = 0.06$; Figure 4). The relatively low r^2 value indicates that survey year (i.e., time) explained only a small proportion of the variation in plover counts. Other factors that potentially affected the overwintering snowy plover population at Ocean Beach include regional snowy plover breeding productivity, snowy plover survivorship, weather, and availability of nearby alternative wintering sites.

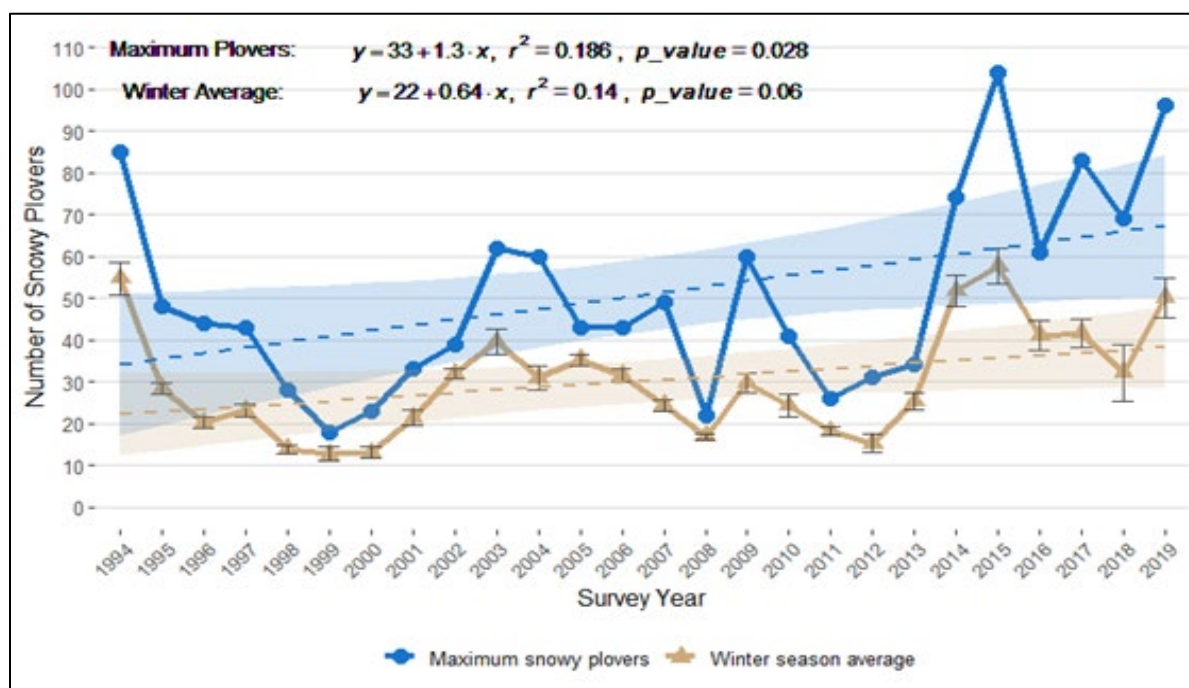


Figure 4. Winter season averages ($\pm$ SE) and survey-year maxima for snowy plovers on Ocean Beach from 1994 to 2019. Dashed lines represent trends using linear regression and colored shading indicates 95% confidence intervals.

GOGA plover counts have varied over the 26 years of monitoring (see also Townsend and Merkle 2020). The population appeared to have declined from 1994 through 1999 and then gradually increased since then. Encouragingly, from 1994 to 2019, the maximum number of plovers per survey year increased ($r^2 = 0.186$, $p = 0.028$). Ten of 26 monitoring years had maximum plover counts greater than 60 plovers, with six of those ten occurrences in the years from 2014 to 2019. We

recently initiated a long-term trend analysis that will provide more details on changes in snowy plover abundance over time.

Temporal and Spatial Distribution

Typically, overwintering plovers arrived on Ocean Beach starting in July, with counts peaking around October, and remaining relatively consistent through the winter before tapering off starting in February. By April or May, plover counts usually dropped to nearly zero on Ocean Beach (Figure 5). These patterns generally held true for the 2015 through 2019 survey years (Table 1), with plovers first observed on Ocean Beach from early- to mid-July and last observed during surveys in late April to early May.

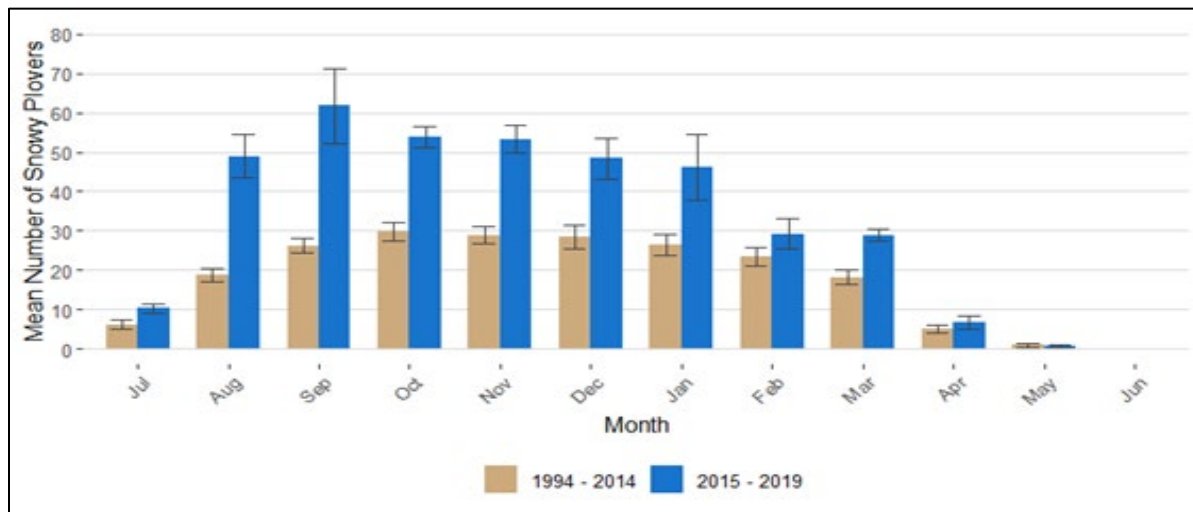


Figure 5. Monthly average ($\pm$ SE) number of snowy plovers observed per survey at Ocean Beach for survey years 1994 through 2014 compared to the same for survey years 2015 through 2019.

Table 1. First and last dates snowy plovers were observed at Ocean Beach and snowy plover counts observed on those dates for survey years 1994 through 2019.

Survey Year	First Complete Survey	First Date Plovers Found	Complete Survey?	# On First Date	Last Complete Survey	Last Date Plovers Found	Complete Survey?	# On Last Date	Season Length
1994	1994-12-08	1994-12-08	Yes	69	1995-05-13	1995-05-13	Yes	2	157 days
1995	1995-07-19	1995-07-19	Yes	17	1996-04-27	1996-04-20	Yes	2	277 days
1996	1996-07-24	1996-07-10	No	4	1997-05-14	1997-04-30	Yes	2	295 days
1997	1997-07-03	1997-07-09	Yes	3	1998-05-20	1998-05-13	Yes	2	309 days
1998	1998-07-11	1998-07-11	Yes	1	1999-04-28	1999-03-31	Yes	7	264 days
1999	1999-07-21	1999-07-21	Yes	4	2000-05-10	2000-04-26	Yes	3	281 days
2000	2000-07-05	2000-07-09	Yes	2	2001-04-11	2001-04-11	Yes	9	277 days
2001	2001-07-12	2001-07-25	Yes	11	2002-04-06	2002-03-30	Yes	12	249 days
2002	2002-07-24	2002-07-24	Yes	8	2003-05-21	2003-05-14	No	2	295 days
2003	2003-07-30	2003-07-30	Yes	10	2004-05-15	2004-04-28	Yes	4	274 days
2004	2004-07-28	2004-07-28	Yes	16	2005-05-25	2005-04-30	Yes	4	277 days
2005	2005-08-10	2005-08-10	Yes	20	2006-04-19	2006-04-22	No	7	256 days

Table 1 (continued). First and last dates snowy plovers were observed at Ocean Beach and snowy plover counts observed on those dates for survey years 1994 through 2019.

Survey Year	First Complete Survey	First Date Plovers Found	Complete Survey?	# On First Date	Last Complete Survey	Last Date Plovers Found	Complete Survey?	# On Last Date	Season Length
2006	2006-07-12	2006-07-26	Yes	13	2007-05-12	2007-04-25	Yes	2	274 days
2007	2007-07-07	2007-07-21	Yes	9	2008-05-14	2008-05-06	Yes	1	291 days
2008	2008-07-02	2008-07-09	Yes	1	2009-05-20	2009-04-29	Yes	2	295 days
2009	2009-07-01	2009-07-22	Yes	7	2010-05-26	2010-05-05	Yes	2	288 days
2010	2010-07-03	2010-08-04	Yes	10	2011-05-31	2011-05-18	Yes	1	288 days
2011	2011-07-20	2011-08-10	Yes	24	2012-05-23	2012-05-09	Yes	1	274 days
2012	2012-07-07	2012-07-07	Yes	1	2013-04-03	2013-03-20	Yes	21	257 days
2013	2013-07-08	2013-07-18	Yes	4	2014-05-16	2014-05-04	Yes	1	291 days
2014	2014-07-02	2014-07-02	Yes	2	2015-06-03	2015-05-27	Yes	1	330 days
2015	2015-07-01	2015-07-01	Yes	3	2016-05-21	2016-05-04	Yes	5	309 days
2016	2016-07-01	2016-07-13	Yes	2	2017-06-01	2017-05-06	Yes	1	298 days
2017	2017-07-01	2017-07-26	Yes	19	2018-05-24	2018-05-05	Yes	2	284 days
2018	2018-07-05	2018-07-13	Yes	8	2019-05-04	2019-04-21	Yes	6	283 days
2019	2019-07-02	2019-07-16	Yes	8	2020-05-13	2020-04-29	Yes	2	289 days

Monthly average plover counts from 2015 through 2019 exceeded monthly averages from 1994 through 2014 for all months except May (Figure 5). In contrast to earlier survey years, plover counts in recent years peaked somewhat earlier—in September as opposed to October—and were more than double the long-term average for that month.

In spatial distribution, 35% of plover observations at Ocean Beach for 2015 through 2019 were in Sector 7, followed by 28% in Sector 6, and 25% in Sector 5 (Figure 6). In comparison, for all snowy plover observations from 1994 through 2014, the observations were more evenly spread across Sectors 5, 8 and 9, which together comprised about 80% of observations. This change indicates that snowy plovers shifted use to more northerly sections of the beach in recent survey years compared to 1994 through 2014.

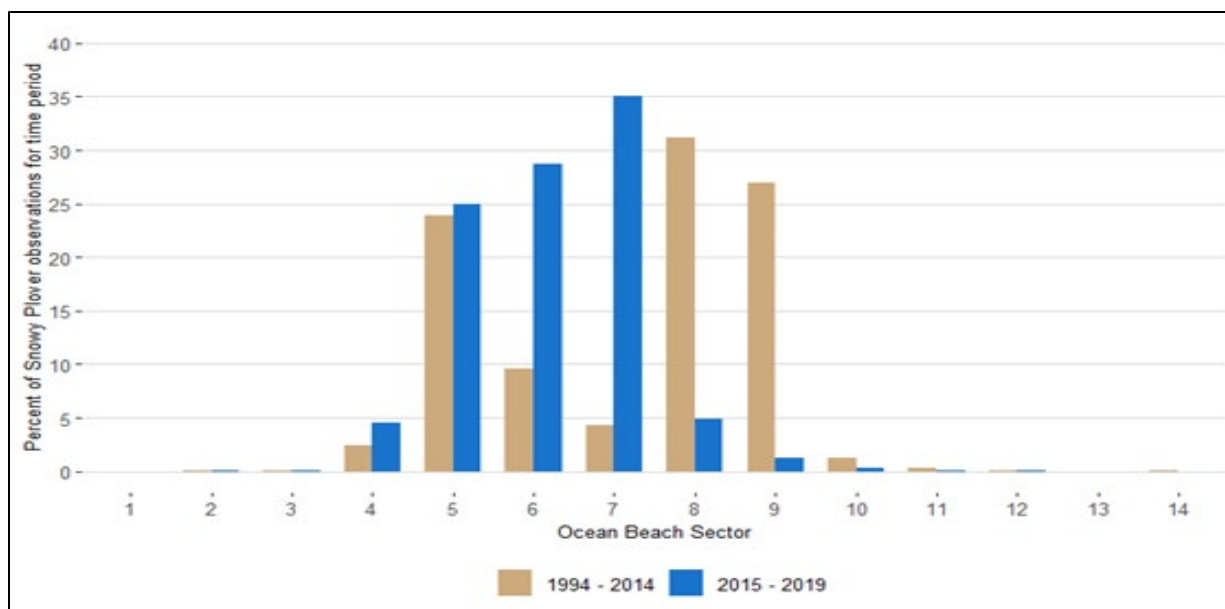


Figure 6. Percentage of snowy plover observations from 1994 through 2014 and from 2015 through 2019 by sector on Ocean Beach. Note that Sector 1 is at the north end and Sector 14 at the south end of Ocean Beach.

People and Dogs

There is no clear trend in the number of people encountered in recent years or across the entire 26 years of surveys (Figure 7). From 2015 to 2019, the lowest median encounter rate was 62 people per hour in the SPPA on Ocean Beach in 2018; whereas in 2016, we recorded the highest median encounter rate of 108 people per hour. The median number of dogs encountered per hour also varied considerably over the 26 years of monitoring, ranging from a low of five in survey year 2000 to a record high of 19 in survey year 2019.

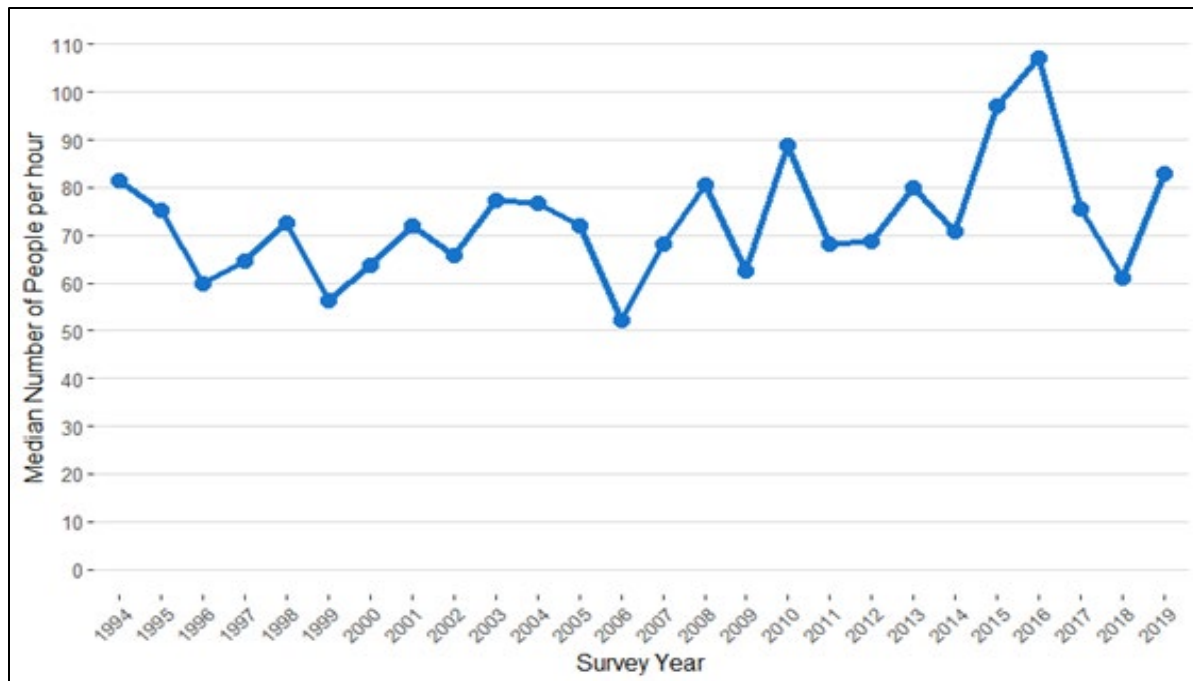


Figure 7. The annual median number of people per hour in the Snowy Plover Protection Area at Ocean Beach (Sectors 4–12) from survey year 1994 to 2019.

From 2015 to 2019, leash compliance rates remained low within the SPPA on Ocean Beach (Figure 8). The percentage of dogs off-leash was highest in 1994 and 1995 (Figure 8) but declined quickly with the start of leash regulations in 1997 (Figure 8, green line labeled “A”) and remained at approximately 60% until 2003. A court decision allowed unleashed dogs again in December 2004 (“B”), and off-leash numbers spiked to 78% for the 2004 and 2005 seasons. When seasonal leash requirements were reinstated in November 2006 (Figure 8, “C”), off-leash dogs declined to a low of 57% in 2007. Since then, off-leash dogs leveled off around 65% for four years and then increased to nearly 80% in recent years. Overall, we observed a pattern of increased compliance in the periods immediately following implementation of these regulations, when there was more emphasis (e.g., signage, outreach, and law enforcement patrols) on achieving compliance (Figure 8).

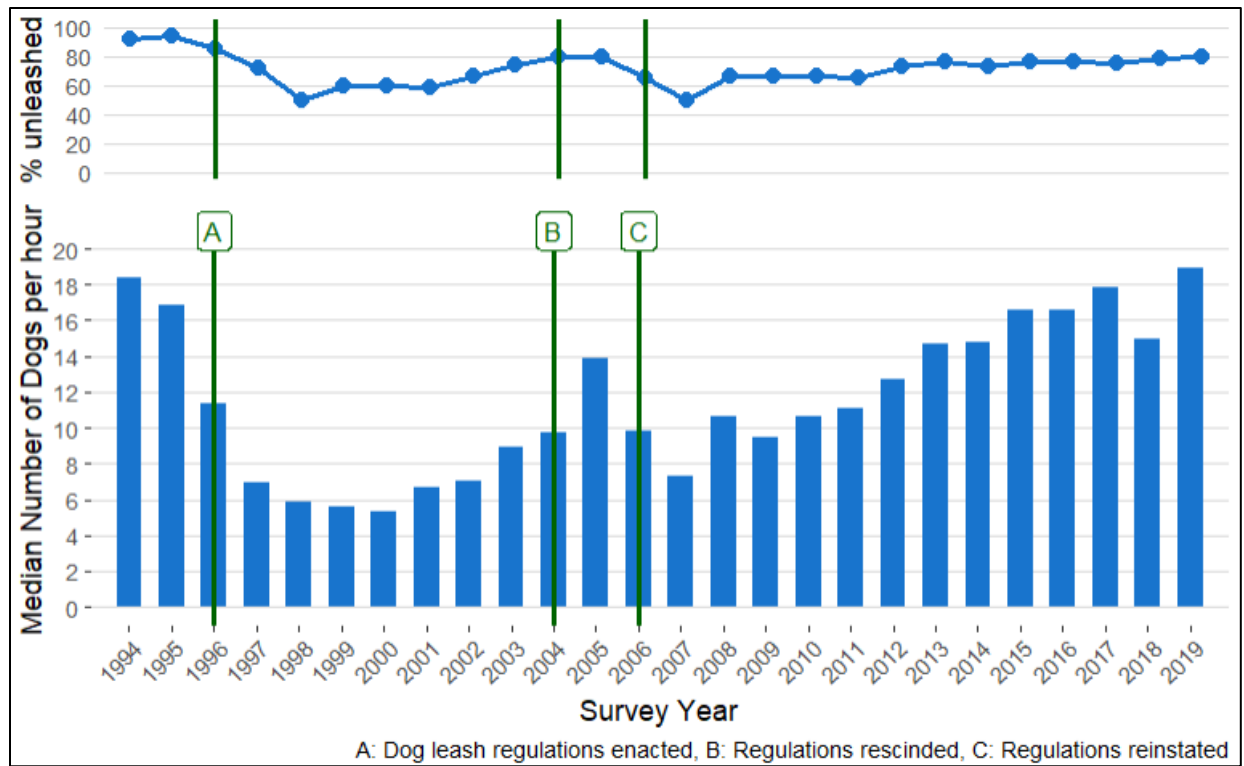


Figure 8. Median number of dogs per hour and percentage of dogs unleashed at the Ocean Beach Snowy Plover Protection Area, from survey year 1994 to 2019, including changing leash regulations (A–C).

Results: Crissy Field

Overwintering Population Size

From 1-July 2015 to 2-May 2020, the survey team conducted approximately 20 complete surveys per survey year on Crissy Field. The average snowy plover count for survey years 2015–2019 was higher than that for 2006–2014 (5.3 and 2.7, respectively) (Figure 9). In 2019, we observed record high counts at Crissy Field with a maximum of 12 individuals and a winter season average of 7.8 plovers. From 2006 to 2019, both winter season averages and maximum counts increased on Crissy Field with $p=0.045$ and $p=0.0054$, respectively (Figure 9). Overall, snowy plover counts at Crissy Field WPA were considerably lower than those observed at Ocean Beach.

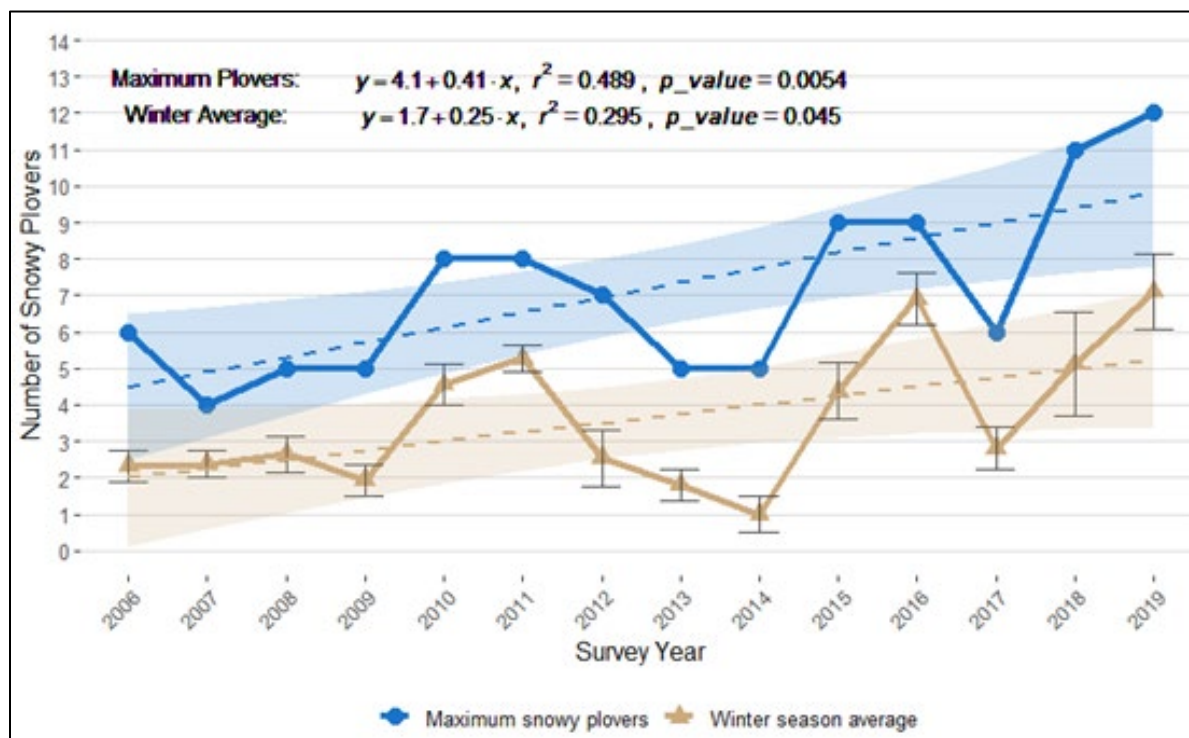


Figure 9. Winter season averages ($\pm$ SE) and survey-year maxima for snowy plovers on Crissy Field from 2006 to 2019. Dashed lines represent trends using linear regression, and colored shading indicates 95% confidence intervals.

Temporal and Spatial Distribution

In general, monthly average plover counts on Crissy Field from 2015 through 2019 were higher than previous years (Figure 10). In earlier years, we counted slightly more plovers in the months of August through October, whereas in recent years we counted more plovers in the winter and spring, most notably in February and March. Plovers tend to arrive later and leave earlier in the season on Crissy Field, than on Ocean Beach (Table 2). These patterns held true for the 2015 through 2019 survey years. Regarding the spatial distribution, we observed snowy plovers only in Sector 2, the Crissy WPA east of the US Coast Guard pier, during the 2015 through 2019 survey years.

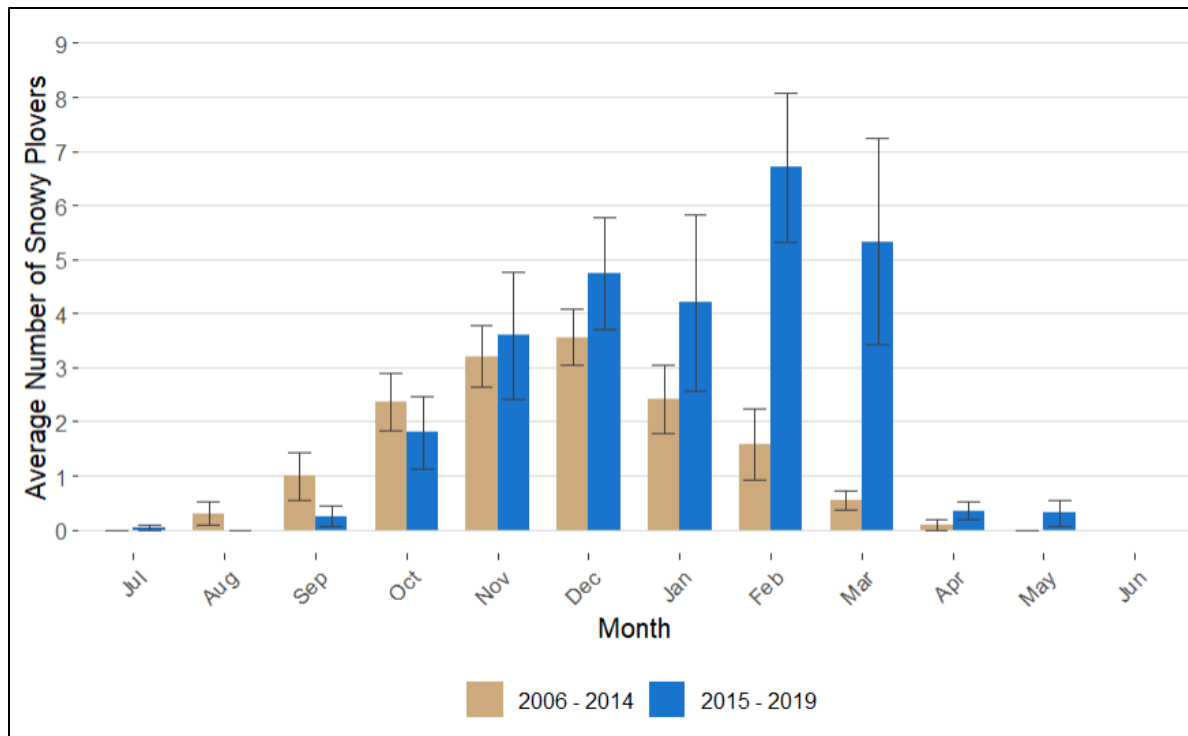


Figure 10. Monthly average ($\pm$ SE) number of snowy plovers observed per survey at Crissy Field for survey years 2006 through 2014 compared to the same for survey years 2015 through 2019.

Table 2. First and last dates snowy plovers were observed at Crissy Field and snowy plover counts observed on those dates for survey years 2006 through 2019.

Survey Year	First Complete Survey	First Date Plovers Found	Complete Survey?	# On First Date	Last Complete Survey	Last Date Plovers Found	Complete Survey?	# On Last Date	Season Length
2006	2006-09-21	2006-09-21	Yes	4	2007-04-18	2007-02-24	Yes	3	157 days
2007	2007-07-05	2007-08-02	Yes	1	2008-04-16	2008-03-15	Yes	2	227 days
2008	2008-07-02	2008-08-06	Yes	1	2009-05-28	2009-03-04	Yes	3	211 days
2009	2009-07-02	2009-09-30	Yes	1	2010-05-19	2010-03-03	Yes	2	155 days
2010	2010-07-03	2010-10-27	Yes	5	2011-04-24	2011-04-24	Yes	1	180 days
2011	2011-07-20	2011-09-28	Yes	2	2012-05-09	2012-03-21	Yes	1	176 days
2012	2012-07-07	2012-09-05	Yes	2	2013-04-03	2013-03-06	Yes	2	183 days
2013	2013-07-09	2013-10-23	Yes	4	2014-05-04	2014-01-29	Yes	2	99 days
2014	2014-08-06	2014-10-22	Yes	5	2015-03-18	2015-01-03	Yes	1	74 days
2015	2015-07-01	2015-09-26	Yes	3	2016-05-21	2016-05-06	Yes	3	224 days
2016	2016-07-01	2016-07-16	Yes	1	2017-06-01	2017-03-21	Yes	4	249 days
2017	2017-07-01	2017-10-17	No	1	2018-05-24	2018-05-03	Yes	1	199 days
2018	2018-07-05	2018-10-17	Yes	3	2019-05-02	2019-04-04	Yes	2	170 days
2019	2019-07-02	2019-10-11	Yes	1	2020-05-02	2020-03-04	Yes	10	146 days

People and Dogs

There was no discernable trend in the rates of people per hour in the Crissy Field WPA over the 14 survey years (Figure 11). The median rate of observed people per hour varied during the 2015 through 2019 seasons, ranging from 23 in 2017 to 68 in 2016 (Figure 11).

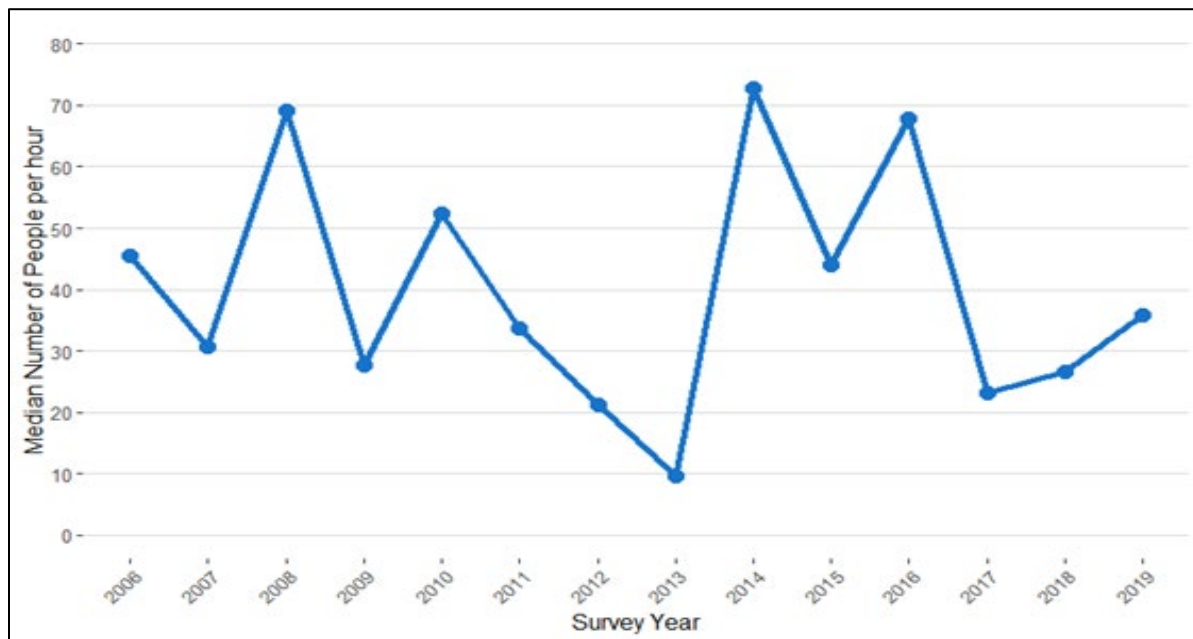


Figure 11. The annual median number of people per hour in the Crissy Field Wildlife Protection Area, from survey year 2006 to 2019.

During the period 2015 to 2019, the median rate of dogs per hour ranged from less than three in 2015 to six in 2018 (Figure 12), and compliance with leash regulations appeared extremely high, with a median value of 0% of dogs off-leash. However, these estimates were confounded by short survey visits resulting in the potential for artificially low estimates of dog occurrence and artificially high estimates for leash compliance.

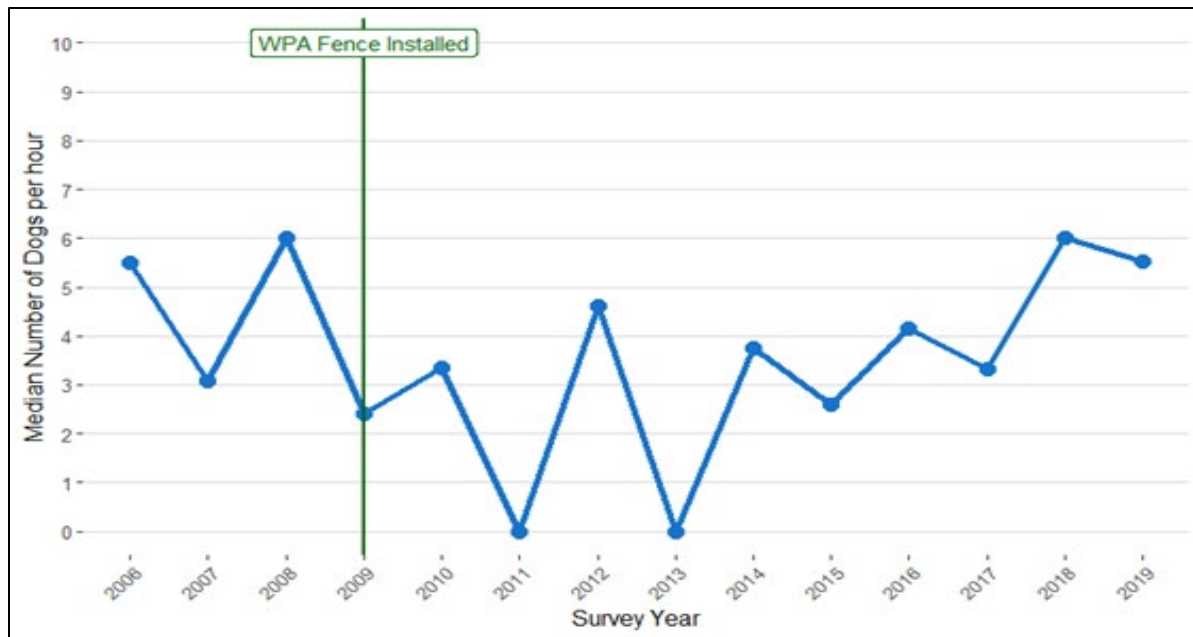


Figure 12. Median number of dogs per hour at the Crissy Field Wildlife Protection Area (WPA), from 2006 through 2019. Green line indicates when the WPA fence was installed.

Discussion

Overall, snowy plover counts on Ocean Beach and Crissy Field have varied over time, with counts since 2014 being mostly higher than the long-term average of plovers recorded at both sites. These recent higher overwintering counts potentially relate to observed increases in nesting adults at nearby breeding sites in Marin and Monterey counties in 2014 (Page et al. 2015). Plover counts on Ocean Beach peaked earlier—in September—during the 2015 through 2019 seasons, whereas counts historically peaked in October. Weather patterns may explain some of these observations. For example, Northern California endured a long period of drought from 2011 into 2016. The mild dry winters associated with the drought may have been favorable to adult survival and may partly explain the higher-than-average plover counts observed since the 2014 survey year.

Snowy plovers are associated with wider stretches of beach and are most frequently detected roosting in open, sparsely vegetated habitats which presumably facilitate early detection of danger posed by approaching predators (Brindock and Colwell 2011). From 1994 through 2014, we most often observed snowy plovers on Ocean Beach in Sectors 8 and 9 where the beach was wide and open. In recent years, the beach has narrowed in those middle sectors and is currently wider further north. Subsequently, during the 2015 through 2019 survey years, most plover observations were in Sectors 6 and 7 (Figure 6), corresponding to the new location of the wider stretch of beach. Data collected through the snowy plover monitoring program will be important for assessing potential impacts of pending proposals for erosion control measures and nourishment of Ocean Beach that are intended to protect City of San Francisco infrastructure. Analyzing snowy plover counts and spatial distribution in relation to regularly monitored beach transects may clarify this relationship at Ocean Beach.

In contrast to the unambiguous changes in plover spatial distribution, the number of people per hour on Ocean Beach has fluctuated over the years, with generally higher numbers observed since 2008, reaching a record of over 100 people per hour during the 2016 season. We did not analyze human spatial distributions and their potential effects on plovers for this report, but we may include that information in a longer-term analysis. Like other popular beach areas, NPS has struggled to gain visitor compliance with leash regulations for dogs at Ocean Beach (Figure 8). High rates of dog use and changing regulations over time have made achieving compliance difficult. Ocean Beach is also a challenging area to sign, as it is about four miles long with beach access approximately every two city blocks. More outreach and a persistent enforcement effort by GOGA would likely increase compliance with leash regulations and thereby reduce disturbance of snowy plovers and other shorebirds on Ocean Beach.

Compared to Ocean Beach, Crissy Field supports a much smaller population of overwintering snowy plovers. The reasons this population is smaller are unclear but may be associated with the smaller size of the protected area at Crissy Field than at Ocean Beach. In addition, Crissy Field may support lower productivity of invertebrate food resources, thereby resulting in fewer plovers. Similar to observed patterns in plover abundance, we observed much higher abundance and diversity of other shorebirds at Ocean Beach than at Crissy Field.

Additionally, historical observations at Crissy Field do not date as far back in time as those at Ocean Beach. In 2016, average plover counts peaked at seven individuals, declined to three in 2017, then increased in 2018 and 2019. Survey year 2019 exhibited the highest average and maximum counts since monitoring began, with almost eight plovers observed per survey and a maximum of 12 individuals observed in a single survey.

Corresponding to the higher plover counts in recent years, we also encountered fewer humans and dogs in the WPA on Crissy Field during this time period. In January 2010, NPS staff installed fencing and additional signage along the border of the WPA. Thereafter, we observed a decrease in off-leash dogs. Of note, we often observed beach visitors and their dogs approaching the fence and turning back without entering the WPA. In addition to the potential influence of signage around the WPA, the low counts of humans and dogs within the Crissy Field WPA may in part be attributed to the smaller area of the WPA compared to the SPPA on Ocean Beach and the correspondingly shorter amount of time surveyors spent there.

Managing a threatened species on beaches in urban San Francisco is challenging because numerous people and dogs visit these beaches, and many potentially disruptive projects occur on or adjacent to these beaches. That said, the NPS serves to preserve and protect native species such as western snowy plovers (NPS 2006b). Furthermore, NPS serves as a primary partner with the United States Fish and Wildlife Service in the recovery of federally listed species (NPS 2006b), like the threatened western snowy plover. Our long-term monitoring data indicate possible increases in snowy plover overwintering populations at both Ocean Beach and Crissy Field. Continued monitoring, completing a long-term trend analysis, and building a plover population model all will assist in teasing out these relationships. The presence of plover surveyors on park beaches twice every other week for most of the year helps ensure that we observe conditions and activities in these areas on a regular basis which may lead to ideas for improved management. For example, data from the snowy plover monitoring program informed when and where projects on these beaches could occur (e.g., sand movement projects and beach nourishment). Furthermore, data from the monitoring program demonstrate that off-leash dogs in our snowy plover protection area at Ocean Beach is an ongoing problem. As such, we will continue to develop strategies to improve outreach, signage, and enforcement to address this issue.

Literature Cited

- Adams, D., S. Allen, J. Bjork, M. Coopridge, A. Fesnock, M. Koenen, T. Leatherman, S. O'Neil, D. Press, D. Schirokauer, B. Welch, and B. Witcher. 2006. San Francisco Bay Area Network Vital Signs Monitoring Plan. NPS/SFAN/NRR 2006/017. National Park Service, Fort Collins, Colorado.
- Burger, J. 1986. The effect of human activity on shorebirds in two coastal bays in the northeastern United States. *Environ. Conserv.* 13:123–130.
- Brindock, K. M., and M. A. Colwell. 2011. Habitat selection by Western Snowy Plovers during the nonbreeding season. *J. Wildlife Management* 75:786–793.
- Hatch, D. A. 1996. Western snowy plover wintering population and interaction with human activity on Ocean Beach, San Francisco, Golden Gate National Recreation Area, 1988 through 1996. Unpublished Report. Golden Gate National Recreation Area, San Francisco, California.
- Heberger, M., H. Cooley, P. Herrera, P. H. Gleick, and E. Moore. 2011. Potential impacts of increased coastal flooding in California due to sea-level rise. *Climatic Change* 109 (Supplement 1: pp. 229–249).
- Jones & Stokes Associates, Inc. 1996. Environmental assessment for Crissy Field plan. June. JSA 95-127. Sacramento, CA. Prepared for National Park Service, Golden Gate National Recreation Area, San Francisco, California.
- Klein, M. L. 1993. Waterbird behavioral responses to human disturbance. *Wildlife Soc. Bull.* 21: 31–39.
- Lafferty, K. D., D. Goodman, and C. P. Sandoval. 2006. Restoration of breeding by snowy plovers following protection from disturbance. *Biodiv. Conserv.* 15:2217–2230.
- Merkle, B., D. Press, R. Townsend, D. Adams, and M. Koenen. 2014. Snowy plover monitoring protocol for Golden Gate National Recreation Area: Version 2.4. Natural Resource Report NPS/SFAN/NRR—2014/896.
- National Park Service (NPS). 2006a. Status report: Western snowy plovers and recent changes in human and dog use within the Snowy Plover Management Area at Ocean Beach and the Wildlife Protection Area at Crissy Field. Unpublished Report. Golden Gate National Recreation Area, San Francisco, California.
- National Park Service (NPS). 2006b. Management policies 2006. 180 pp.
- National Park Service (NPS). 2016. Final Dog Management Plan / Environmental Impact Statement. Golden Gate National Recreation Area, San Francisco, California

- Page, G. W., and L. E. Stenzel. 1981. The breeding status of the snowy plover *Charadrius alexandrinus* in California, USA. *Western Birds* 12:1–40.
- Page, G., F. C. Bidstrup, R. J. Ramer, and L. E. Stenzel. 1986. Distribution of wintering snowy plovers in California and adjacent states. *Western Birds* 17(4):145–170.
- Page, G. W., K. K. Neuman, J. C. Wariner, C. Eyster, J. Erbes, D. Dixon, A. Palkovic, and L. Stenzel. 2015. Nesting of the Snowy Plover in the Monterey Bay Area, California in 2014. Unpublished data.
- Page, G. W., M. A. Stern, and P. W. C. Paton. 1995. Differences in wintering areas of snowy plovers from inland breeding sites in western North America. *Condor* 97:258–262.
- R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.
- Shuford, W. D., and T. Gardali, editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. *Studies of Western Birds* 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.
- Stenzel, L. E., G. W. Page, and D. Hatch. 1995. Snowy plover monitoring program volunteer handbook (includes minor revisions made in 1999). Unpublished Report. Point Reyes Bird Observatory, Stinson Beach, California.
- Townsend, R. K., and W. W. Merkle. 2020. Monitoring western snowy plovers in Golden Gate National Recreation Area: 2014 report. Natural Resource Report NPS/SFAN/NRR—2020/2065. National Park Service, Fort Collins, Colorado.
- United States Fish and Wildlife Service (USFWS). 1993. Determination of threatened status for the Pacific coast population of the western snowy plover, final rule. *Federal Register* 58(42):12864–12874.
- United States Fish and Wildlife Service (USFWS). 2007. Recovery plan for the Pacific coast population of the western snowy plover (*Charadrius alexandrinus nivosus*). In two volumes. Sacramento, California. Xiv + 751 pages.
- United States Fish and Wildlife Service (USFWS). 2019. 5-YEAR REVIEW Western Snowy Plover [Pacific Coast population Distinct Population Segment] (*Charadrius nivosus nivosus*).
- Zlatunich, M. 2007. Western snowy plover monitoring at the Crissy Field Wildlife Protection Area of the Presidio of San Francisco and the Relative Impact of Human Disturbance 2006/2007. Golden Gate Audubon, San Francisco, California. 12pp.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 641/191613, December 2023

National Park Service
U.S. Department of the Interior



[Natural Resource Stewardship and Science](#)

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525